WHITEBAIT

By GILBERT WHITLEY

(Contribution from the Australian Museum, Sydney.)

When Captain Cook's men were at Dusky Bay, in the South Island of New Zealand, on Sunday, April 18, 1773, John R. Forster, one of the naturalists, noticed "a small species of fish (*esox*), without scales, resembling a little trout; its colour was brown, and mottled with yellowish spots in the shape of some ancient Asiatic characters," in an inland lake.

This was the earliest mention of an Australasian fish of the family Galaxiidae, the puzzling assemblage of Southern Hemisphere fishes, which includes the Whitebait of New Zealand, and the Mountain Trout, Minnow, Jollytail, Eel Gudgeon, or Native Trout of Australia.

Forster called his fish *esox*, which is Latin for pike, but Cuvier, the French anatomist, separated our fishes from the pikes under the name *Galaxias*, which means The Milky Way, or a galaxy of stars, perhaps in reference to their coloration.

The Galaxiidae are mostly found in fresh water, from sea-level to the tops of mountains; some, like the Whitebait, migrate to and from salt water, but probably do not travel very far out to sea. About seventy species of *Galaxias* (in the broad sense) have been described from the following countries:—

Southern Queensland
New South Wales
Victoria
Tasmania
North and South Islands of New Zealand
Sub-Antarctic Islands of New Zealand (Aucklands, Chathams, and Campbell)
South Australia
South-western Australia
Argentina
Patagonia and adjacent islands
Chile
Magellan Straits
Tierra del Fuego
Falkland Islands
South Africa

In the Australian Museum there are specimens of Whitebait (*Austrocobitis attenuatus*) from Lord Howe Island, South Pacific Ocean, which may therefore be added to this list.

It will be noticed that all these places are included in a huge circle drawn with the South Pole as the centre, and with the circumference near the 30° S. lat. meridian. Only two nominal

species transgress these bounds. *Galaxias indicus*, Day, from Madras, is only superficially like a *Galaxias*, and belongs to some other genus, not yet determined. *Galaxias neocaledonicus*, Weber and Beaufort, from New Caledonia, is also not a true Galaxiid, and may receive the new generic name *Nesogalaxias*. Thus these two species may be dismissed from further consideration.

The remarkable distribution of the now mainly freshwater Galaxiidae has provided food for thought as to the origin of the group and its possible association with land-links now long vanished, or with a hypothetical Antarctic continent. No satisfactory reason seems to have been advanced, but perhaps the best expressed is that of Theodore Gill in the *Memoirs of the National Academy of Sciences*, Washington (Vol. vi., 1893, pp. 107-108), though Regan, Hedley, Waite, and other zoologists have pondered the problem. Gill wrote: "The fresh-water fishes [of New Zealand] must have been derived from the same common source as those of the isothermal portions of Australia (of course including Tasmania) and South America. There may not have been a continuity of land at any one time between South America, Australia, and New Zealand but, at some remote period in the past, it is at least possible that there was a region in which the Galaxiids . . . . . were developed, and subsequently representatives . . . . . might have found their way into the regions where they now abound. But, it may be urged, such a derivation is only possible, and there may have been other means for diffusion. . . . ."

Gill then proceeded to enumerate the possible means of dissemination which had been formulated by various people:—

"(a) The progenitors of the existing species may have been, for example, entombed in masses of ice, and such may have been carried into the ocean and wafted to distant regions, where they may have found congenial waters, been liberated from their long imprisonment, mated, and propagated their race.

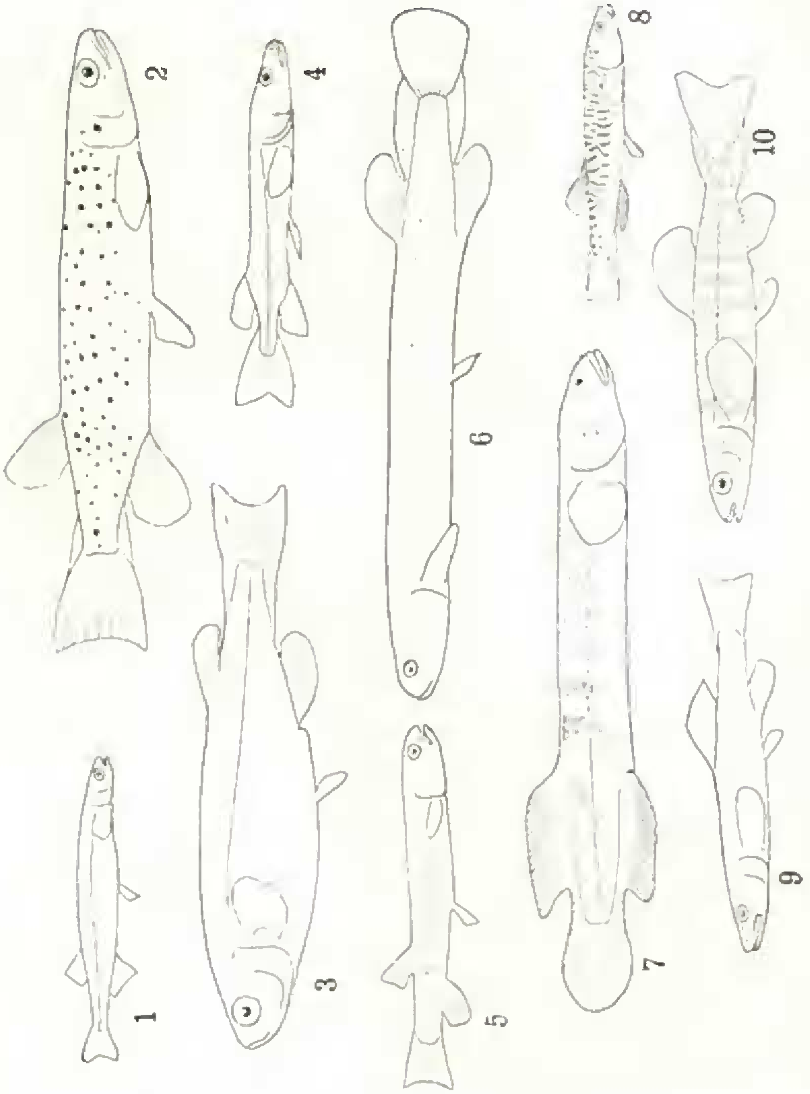
"(b) They may have even survived a long sojourn in salt water into which they wandered.

"(c) They may have originated from congeneric species formerly existing in the ocean, but now extinct therein and restricted to fresh water."

And again: "According to others, community of type must be the expression of community of origin, and the presence of fishes of long-established fresh-water types must imply continuity or at least contiguity of the lands in the midst of which they occur at some one time or other."

Gill considered that while a few kinds of animals might have been distributed "in some such unnatural manner as has been suggested [i.e. (a) and (b), above], it is highly improbable that *all* the forms common to the distant regions could have been so distributed."

Plate III



Generic types of Galaxiidae, from various sources.

Fig.
1. *Austrocobitis attenuatus* (N. Zealand).
2. *Galaxias truttaceus* (Victoria).
3. *Brachygalaxias bullocki* (Chile).
4. *Nesogalaxias* (gen. nov.) *neocaledonicus* (N. Caledonia).
5. *Lyragalaxias* (gen. nov.) *oconnori* (Queensland).
6. "*Galaxias*" *burrowsius* (New Zealand).
7. *Neochanna apoda* (New Zealand).
8. "*Galaxias*" *zebratus* (S. Africa).
9. *Querigalaxias* (gen. nov.) *dissimilis* (New South Wales?).
10. *Paragalaxias shannonensis* (Tasmania).

Since we have no knowledge of fossil *Galaxias*, the palaeontological history of the group is unknown, and fossil molluscs and mammals are so similar and dissimilar respectively when compared with their modern representatives that little help can be anticipated from that quarter.

Gill's summing-up was as follows:—

"In the present stage of science, then, we may be permitted to postulate (fishes being congeneric in New Zealand, Australia, and South America) that there existed some terrestrial passage-way between the several regions at a time as late as the close of the Mesozoic period. The evidence of such a connection afforded by congeneric fishes is fortified by analogous representatives among insects, mollusks, and even amphibians. The separation of the several areas must, however, have occurred little later than the early Tertiary, inasmuch as the salt-water fishes of corresponding isotherms found along the coasts of the now widely-separated lands are to such a large extent specifically different. In general, change seems to take place more rapidly among marine animals than fresh-water representatives of the same class."

My own view is that the group originated in the cold southern seas between the present site of New Zealand, and acquired the habit of entering rivers of adjacent land-masses. The waters of Antarctica were too cold for them, and those north of about 30° S. lat. too warm. There is a somewhat parallel case in the Salmon and Whitefish families of Palæarctic regions. Whether the Galaxiids are as ancient as the times when the continents drifted apart, as Wegener postulated, cannot be known, but their ancestors may have been. These fishes, originally marine, came to settle more and more in the rivers of the separating land-masses until the intervening seas cut them off permanently from their fellows. Now, most of the species live entirely in fresh water, breeding there, but some, more old-fashioned than the rest, descend to the sea to lay their eggs, a tribute to tradition.

In this connection, certain other animals with similar distribution to that of the Galaxiidae may be mentioned. Certain shells and loricates are found in South America and Tasmania, as well as on Kerguelen and other isolated circum-Antarctic islands, where *Galaxias* has so far not been found. The Lampreys of the genus *Geotria* are very similar in Australia, New Zealand, and South America. So are some of the purely marine fishes: Barracouta, Kelp-fish, Nototheniids, and others, whilst ornithologists find the same similarity in Petrels, Gulls, and Cormorants from those regions.

In discussing the origin of the fresh-water fishes of New Zealand, W. J. Phillipps wrote (*Nature*, April 3, 1926):—

"The Galaxiidae as a family are worthy of mention in that in New Zealand the highest development and the lowest degeneration

of the family have taken place. Eleven members of the family are known in New Zealand fresh waters, the young of *Galaxias attenuatus* running from the estuaries of rivers in the spring months and forming the chief constituent of the southern Whitebait. Though this species is found both in Australia and South America, it appears to be not nearly so prolific in those countries. Thus, it is quite possible that, in the Cretaceous period, when the New Zealand area was much greater, the Galaxiidae, which had originated here, then spread to adjoining land-masses. The

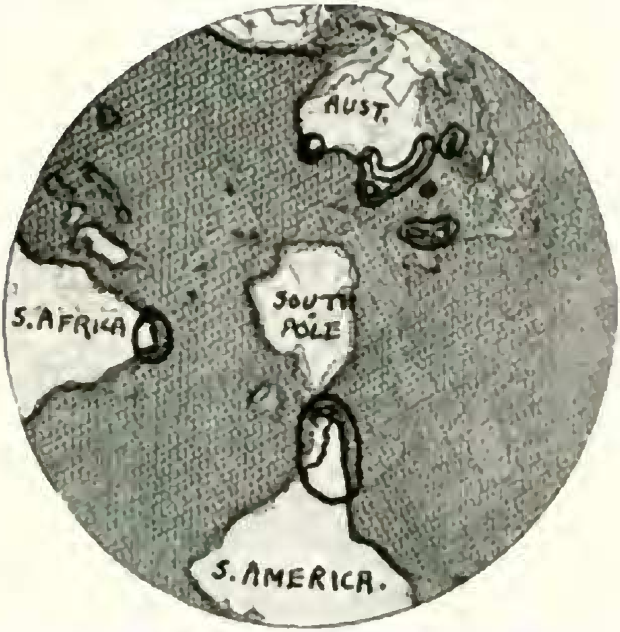


FIG. 1. Map showing circum-Antarctic distribution of the Galaxiidae. (Modified from Matthew.)

degenerate members of the family are *Galaxias burrowsius* and *Neochanna apoda*, the former having almost lost the use of the ventral fin, while in the latter it has quite disappeared. These fish both hibernate during dry weather, and are peculiar to New Zealand." These fishes are figured as Nos. 6 and 7 on the accompanying plate.

The New Zealand Whitebait of commerce consists of the young or larval specimens of more than one species of fish which ascend rivers in hordes towards the end of the year. The chief species is usually called *Galaxias attenuatus*, though, strictly speaking, it should be named *Austrocobitis attenuatus*, since it differs very markedly from the typical *Galaxias* (*truttaceus*). Included with this are the young of the smelt (*Prototroctes* and *Retropinna*), and sometimes other small fishes.

When the Whitebait run, nets of all kinds are used by both whites and Maoris, and the packed mass of succulent fish is either consumed locally or canned for export. The quantity of Whitebait varies considerably from year to year, being dependent upon wet or dry seasons and many other factors. Statistics are difficult to obtain, as accurate figures cannot be compiled from incomplete returns from scattered parts of New Zealand. The average wholesale value is about 2/- per pound, or £11 a cwt., but market prices vary for different ports of the Dominion. One or two thousand cwt. of Whitebait are caught each year, of which several thousands of pounds' worth are exported. Probably the 1932 season constituted a record, as 4,748 cwt. of Whitebait, estimated at 500,000,000 individual fishes, valued at £21,620, were caught in the Dominion. Of these, about 42,000 lbs. were canned for export, the value approaching £4,000. When good runs occur like this, prices drop and canneries pack a limited quantity. Sometimes the annual export value exceeds £7,000.

In view of the commercial importance of Whitebait, the New Zealanders rightly decided that the life-history of the species could not be too fully investigated. Apparently the first naturalist to discover the extraordinary breeding habits of the New Zealand Whitebait was D. H. McKenzie, whose account, in *The New Zealand Illustrated Magazine* (Vol. x., pt. 2, May, 1904, pp. 122-126 and 4 figs.), is most informative. McKenzie's observations were made on the Rangitikei River. After noting that the Maoris used the name *Inanga* for fish-fry, rather than the species of fish itself, and *Inangahua* for the adult Whitebait in the breeding season, McKenzie wrote:—

"In the lower reaches of the Rangitikei River, within tidal limits, are mud-flats and muddy creeks, bristling with salt rushes and stranded brush-wood debris.

"During the months of March and April may be seen at high-water spring-tides countless myriads of small fish, from four to six inches in length, making the water literally boil wherever any rushes or brush-wood exist by the river or creek margin. The water, much vexed, has a slightly milky appearance wherever the fish are most numerous. It is spawning time with the inangahua. The ova clings to the rushes and water-plants near the surface of the water, where it remains till the inanga is ready to burst the shell and commit his puny existence to the tender mercies of his countless enemies.

"The shell-bursting is an important epoch in his history, as it is only attained by a curious conjunction of elements. If, at the critical time, tides are slack or the winds asleep—that crop of Whitebait will be very small indeed. For the ova, when ripe, must be washed from its lodgment on rush or fascine by wind and tide combined, or it perishes.

"Let us suppose that the Pacific has been 'rough to be kind,' that the west wind drove up a strong tide and washed the ripe ova from their respective perches. Soon the young fry emerge from their shells, and are driven or drifted out to sea as inanga of the smallest size, there to receive their baptism of salt water."

He goes on to relate how three weeks afterwards the little Whitebait swarm up the Rangitikei River. Their enemies are fish, birds and insects. They then struggle against the current to the headwaters of the Rangitikei.

They struggle upwards day by day. "At night but little progress is made (so says the Maori), but in the day an advance of a mile in three hours has been marked, where the river fell six to seven feet per mile. . . .

"When the inanga reach their summer homes they enjoy themselves after the manner of their kind for a few brief months till February or March. Then, hey presto! off they go down to the salt tide by companies and by legions, hiding by day, by night frisking, leaping, and tumbling . . . back . . . among the rushes and muddy creeks of high-water mark." This naturalist confessed that he did not know what happened to the parent fish after spawning, but thought that they might spend what remained of their lives at sea.

In more recent years, the foregoing observations on the breeding of Whitebait have been confirmed by Captain L. Hayes, so that the Marine Department at Wellington now possesses a fund of information about spawning grounds, seasons of egg-laying and of ascent, and returns of the fisheries. The old Maoris utilised the Whitebait, and foretold its appearance by less scientific means. Nowadays the fish also serves as a food-supply for the Brown and Rainbow Trout, which have been introduced into New Zealand rivers.

Emphasizing the need for protecting the natural Whitebait nurseries, Captain Hayes observed (*Evening Post*, Wellington, N.Z., October 6, 1931, p. 5, and photos.) :—

"Spawning does not take place until the highest of the spring tides has passed. The ova are thus left 'high and dry' when the tide recedes, and since they are deposited as near the water's edge as the fish can get, and the tides which follow are of diminishing size, there can be no further contact with the water until the occurrence of next spring-tides—at the earliest a fortnight later. . . .

"It has been found that if the spring-tides succeeding those during which the spawning took place . . . do not reach the zone where the spawn is deposited, the eggs remain unhatched until a tide sufficiently high to reach them occurs. . . . The spawning may take place at any time between August and June, but the most

considerable movements of the spawning shoals occur between January and May." He then points out a danger:—

"The eggs are deposited on river banks in hundreds of thousands. Horses and cattle trampling over the ground have been shown to be responsible for the destruction of vast numbers of the eggs."

The use of chemical weed-killers for clearing areas for drainage has been even more destructive. Now the Whitebait spawning grounds are being fenced off, and the Marine Department proposes to license those who fish for the Whitebait when the ascent of the rivers occurs.

The old Maoris reaped a great harvest of Whitebait at about the autumnal equinox. Weirs were constructed in the streams to converge into a narrow opening where a "hinaki" or eel trap was placed. Tons of adult fish were caught in this way. These were sun-dried or hung up in kits in the roofs of the whares, where they were partially smoked. The Maoris also caught the young Whitebait, and, according to E. T. Frost (*Weekly News*, Auckland, November 12, 1930, p. 68), did not regard the adult fish as worth taking when they reascended the river after spawning, probably to wait upstream until joined by the new migration.

In 1932, a restriction was imposed on the season for taking Whitebait in New Zealand, and the Maoris objected. They claimed that the regulations did not apply to members of the native race, as they were immune under the Treaty of Waitangi. "Consequently," concluded their spokesman, "no enactment nor regulation can override the Maori fishing rights, which enable Maoris to catch Whitebait in any manner . . . in any New Zealand water. . . . For this we return thanks to the Father, Son, Holy Mother, the Holy Angels, the Faithful Angels, and their and our own mouthpiece, Piri Wiri Tua, for ever and evermore."—*Taranaki Herald*, November 9, 1932.

The Fisheries Department replied that "actually the regulation refers only to the taking of Whitebait for sale. In this respect it will be strictly enforced on Maori and pakeha alike. Maoris will, of course, be able to take Whitebait for their own consumption."—*N.Z. Herald*, November 15, 1932.

For further information on the subject of New Zealand Whitebait, consult the annual reports of the Marine Department, Wellington, and the files of the *New Zealand Herald* for June, 1930, November, 1930, October-November, 1931, and August, 1932; the *Taranaki Herald* for April, October, and November, 1932; and the *Auckland Weekly News*, November, 1932, for the Premier's reply to the Maoris.

The New Zealanders know more about their Galaxiidae than we do of ours in Australia. A form of Whitebait, similar to if not identical with the New Zealand species, appears from about

August to the end of the year in the coastal streams near Sydney. An account of this invasion, which is too small to be of any commercial value, has been given by McCulloch in the *Australian Zoologist* (Vol. i., 1915, p. 47, 2 figs.).

Annually I have seen the little "minnows" coming up from the sea in a creek flowing across Maroubra Beach, and there are still some large ones there now (May, 1935). Unlike the elvers of the Short-finned Eel, which ascend at about the same season, they do not hide themselves during the daytime, but wriggle gaily through the clear water, just like their Old World namesakes in the poetry of Keats.—

"Where swarms of minnows show their little heads,
Staying their wavy bodies 'gainst the streams,
To taste the luxury of sunny beams
Tempered with coolness. How they ever wrestle
With their own sweet delight, and ever nestle
Their silver bellies on the pebbly sand!
If you but scantily hold out the hand,
That very instant not one will remain;
But turn your eye, and they are there again."

I caught some of these Maroubra fishes and placed them on the bank of the stream. By sudden muscular movements they leapt into the air and gradually reached the water again. Similar observations were made by W. J. Phillipps on New Zealand specimens, for he wrote (*N.Z. Journ. Sci. Tech.*, vii., 2, 1924, p. 119):

"In swimming, the young fish elevates its body anteriorly until it appears to move forward at an angle of 45° to the plane of the bottom. It has a remarkable power of clinging to upright objects, and can jump over 6 feet in a direct line. This forced me to keep the top of the aquarium covered, and even then the smallest fish would climb 6 inches out of the water up the vertical glass sides."

Some curious habits of different species of Galaxiidae have been recorded from Australia and New Zealand. Perhaps the most extraordinary member of the group is the native Mudfish of New Zealand (*Neochanna apoda*), which may be described as a *Galaxias* with small degenerate eyes and without ventral fins (Plate III, Fig. 7). They are found under logs or amongst the roots of trees, in clay or mud, even when all the water has dried up, and are some of the very few fishes in the world which may be captured by ploughing!

In the *Victorian Naturalist* (xviii., 1901, p. 65), T. S. Hall reported: "Twelve *Galaxias* sp. dug up in decayed peat and sand eight inches below the surface at Strahan, Tasmania. There was no water, but the soil was moist enough to harbour worms. They lived when placed in fresh water afterwards" . . . "Fish are reported as being occasionally dug up in the button-grass country, on the west coast of the island, and are stated by a miner to have

no eyes, though otherwise similar." Mr. E. O. G. Scott has recently described (*Proc. Roy. Soc. Tas.*, 1933 (1934), p. 41, pl. vi.) a new Tasmanian species, *Galaxias cleaveri*, found in a cavity in the root of a eucalyptus stump which had been blown out of the ground by explosives. It was kept in captivity both in and out of water. At the end of 65¾ hours in a dry vessel it appeared shrivelled, and was put into formalin for preservation, but, to

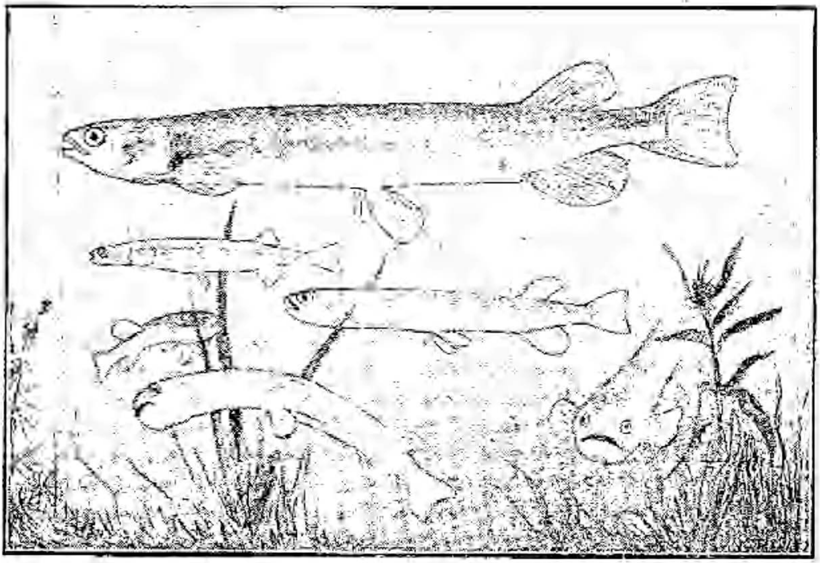


FIG. 2. Whitebait (*Austrocobitis attenuatus*), from New Zealand and Australia (G.P.W., del.)

everyone's astonishment, revived and commenced swimming again. Mr. Scott has also demonstrated that *Austrocobitis attenuatus* can survive out of water for about 25 hours.

Another extraordinary case, probably unique as a fish story, is culled from the *Abstract of the Proceedings* of the Linnean Society of New South Wales for July 31, 1889, as follows:—

"Mr. William Neill, of the City Bank, sent for exhibition 85 small fishes (*Galaxias* sp.), forwarded to him from London. They were a sample of a quantity weighing 224 lbs. taken out of 25 bales of wool shorn on the late Hon. E. Flood's "Midgeon" Station, N.S.W., and subsequently sent to England. The fishes were pumped up from Lake Midgeon in the water used for wool-washing, and became entangled in the wool."

(This reminds me of a small fish found sealed in a tin of Australian fruit by a person in England. The fish had evidently got into the tin with water. An elver of a Short-finned Eel once came through a water-tap in the Australian Museum. At Lithgow,

New South Wales, a Gudgeon blocked a water-pipe, and the following claim was made on the Council: "While we appreciate the efforts of Council to supply the overburdened ratepayers with fish, although minus the chips, we respectfully ask that Council to foot the bill of the plumber (38/7), which is herewith enclosed." —*Daily Telegraph*, Sydney, March 24, 1933.)

As a destroyer of mosquito-larvæ, *Galaxias* is as good as most of our small native fishes, such as *Melanotaenia*, *Pseudomugil*, *Carassiops* and *Ambassis*, and is preferable to the introduced mosquito-eating fishes, which might easily displace ours and become a pest. *Galaxias* is also adept at catching flies. I have noted this habit (*Australian Naturalist*, vii., 1928, p. 59) among some minnows in a pond near Sydney, where a dead rat, floating like a miniature island, attracted numerous flies. The minnows quickly leapt at the flies alighting on this sordid object. Time and again, as I watched, "A gleam of sunlight shone . . . on the fish's silvery gill-cover and moist olive body, as, clinging to the rat by its pectoral fins, it snapped up the fly; there was a little splash as it slipped back into the water, and all was over so quickly that one wondered whether the insect had vanished in a conjuring trick."

I have also seen a Jollytail leap from an aquarium to catch a fly as it flew near the surface of the water, and it did not miss. If only our little minnows were bigger, our anglers would not have had the trouble of introducing trout to the Antipodes—the Australian fishes would have risen to the fly instead.

Mr. E. O. G. Scott, Assistant Curator of the Queen Victoria Museum, Launceston, is at present investigating the different species of Tasmanian Galaxiidae, and has kindly furnished me with a statement of affairs as they stand at present. His researches have shown "that the Galaxiid fauna of Tasmania is decidedly more diversified than has hitherto been realized, and vies in variety with that of New Zealand, traditionally regarded as the headquarters of the family."

Whereas five years ago Tasmania was accredited with but five species of *Galaxias*, Mr. Scott recognises ten or eleven, and he has discovered two new genera as well. One of these he has just named *Paragalaxias shannonensis* (Scott, *Proc. Roy. Soc. Tas.*, 1934 (1935), p. 41, pl. iii.), but the other has yet to be christened by him. This unnamed genus is "intermediate between *Galaxias* and *Neochanna*, resembling the latter in having no teeth on the palate, and in having long, low dorsal and anal fins, and agreeing with the former in possessing ventral fins, though these are reduced," thus recalling the New Zealand *Galaxias burrowsius* (see Fig. 6 on plate herewith).

Mr. Scott (*in lit.*, March 7, 1935) further remarks: "In many streams in Tasmania (as elsewhere) the Galaxiidae have been

wholly or largely displaced by the introduced Salmonidae; this appears to apply with special force to some of the western districts. Where food is abundant, however, they still survive in considerable numbers under these conditions; if well supplied with food, they can be kept in the same pond with Salmonidae.

"There is some evidence to suggest that in Tasmania the Galaxiidae, like the Salmonidae in their native waters, tend to form varietal forms more or less characteristic of different localities when the latter are adequately isolated."

The Galaxiidae are notoriously variable in their proportions, positions of fins, and colours, so that it is difficult to define the various species, and the "systematics" of the group are in a parlous state, in spite of the excellent revision of the family by Regan (*Proc. Zool. Soc.* (*Lond.*), 1905, ii., pp. 363-384, pls. x.-xiii.), upon which all later work is based.

Occasionally examples come to light with black spots on the body and fins. Each spot is found to be caused by an object like a pip, embedded just under the skin, and is not a colour-mark. I have found similar bodies in the smelt (*Retropinna*). These things are really the encysted stages of parasitic worms (*Clonorchis*), surrounded by pigment produced by the fish, which is the second intermediate host of the parasite.

Another curious feature about a Tasmanian specimen was the fact that it had two mouths. Apparently the throat had been torn, and the hole in it was used in place of the old mouth. Details of this interesting case, which was mentioned by R. M. Johnston, the Tasmanian naturalist, in 1908, are unfortunately lacking.

As an aquarium pet, *Galaxias* does well, and is very popular with aquarists, as the fish become quite tame, and can be fed from the fingers, chopped worms being a favourite dish. A correspondent of mine, Mr. Frank Walford, kept the Mountain Minnow (*Galaxias coxii*) under observation in a pond in his garden in the Blue Mountains, N.S.W., and they lived even when the water surface was completely frozen for a week. He noted the habits of the species in its natural haunts in mountain creeks, and sent me specimens of its growth stages. His discovery that *Galaxias coxii* bred in fresh water (see *Australian Museum Magazine*, iii., 8, 1928, pp. 274-277, and Fig.) helped to shatter the old belief that all *Galaxias* had to struggle to the sea to breed, and that their geographical distribution was not particularly limited.

There are several kinds of *Galaxias* in Victoria, and it is hoped that the details, meagre though they be, which are given in this article, may act as an incentive to Victorian field naturalists to find out all they can about these extraordinarily interesting and useful little fishes.